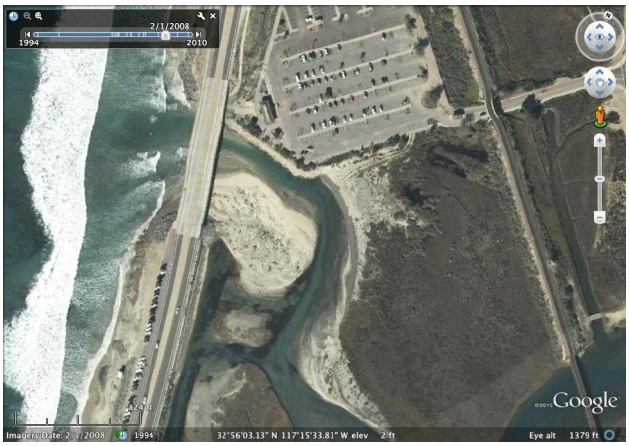
STUDENT MASTER

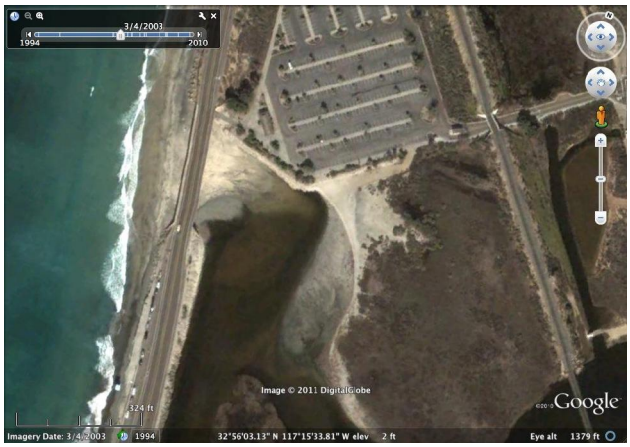
(Don't) Shut Your Mouth

Los Peñasquitos Lagoon

Los Peñasquitos Lagoon is a small estuarine ecosystem in San Diego, California. Human activity in the area of the lagoon has caused changes to the estuary system. For example, the construction of a railroad trestle causes the lagoon mouth to close more frequently than it would naturally. When these mouth closures occur, water from the ocean is less likely to reach the lagoon. With less water coming in from ocean, the overall health of the estuarine ecosystem suffers.

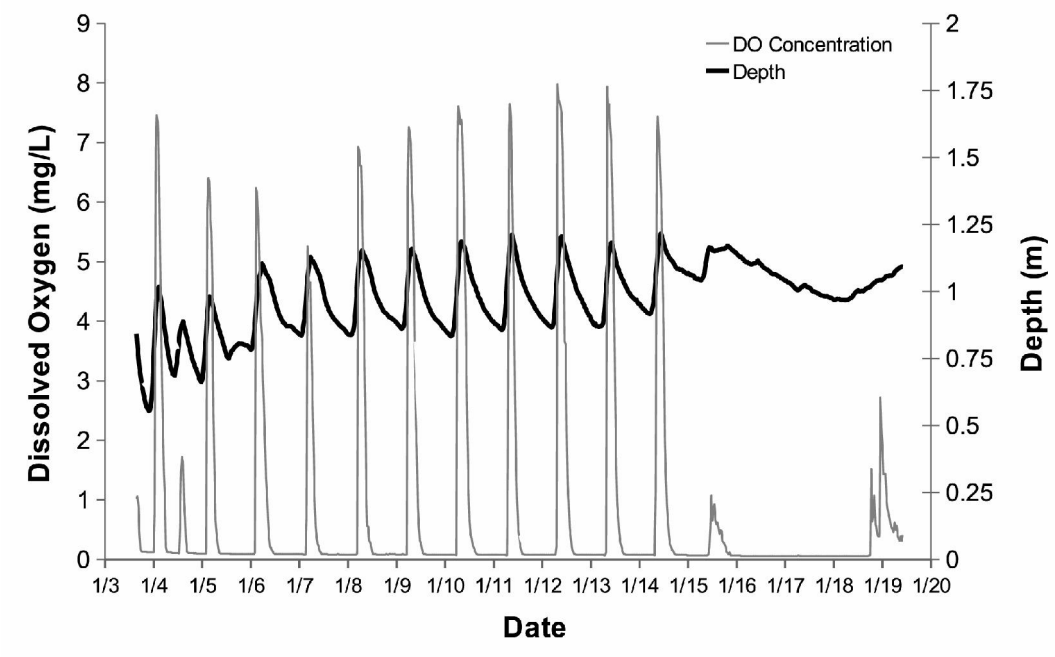


Los Peñasquitos Lagoon during open conditions.



Los Peñasquitos Lagoon during closed conditions.

Let's look at how a mouth closure affects Los Peñasquitos Lagoon. The graph below shows dissolved oxygen and water depth (samples taken every 15 minutes) during a 17-day period when a mouth closure event occurred:



Los Peñasquitos Lagoon During and Following a Mouth Closure

The estuary's mouth wasn't fully closed during the first two weeks shown on the graph. On January 5, the mouth is open. You can see two high tides and two low tides. This is the normal semi-diurnal tide characteristic of the region. However, over the next couple of days, the two high tide spikes seem to become one. The tides haven't changed. So what happened? You may notice that the overall water level in the lagoon is gradually increasing. A sill or barrier is forming at the estuary mouth. Water is piling up in the lagoon behind the sill. Now there is just one tidal exchange per day, indicating that only the higher tides make it into and out of the lagoon. During the last week, you see no tidal water exchange on the graph. The mouth of the estuary is fully closed.

Looking at dissolved oxygen, you can see a very clear relationship with the tidal exchange. When well-oxygenated ocean water flows in the lagoon at high tide, oxygen shoots up. When tides begin to ebb, anoxic (low oxygen) water from the lagoon and watershed moves past the data logger. As the mouth becomes increasingly blocked, the tidal water exchange decreases and finally ceases. The water becomes hypoxic, increasing the possibility of events such as large-scale fish kills.

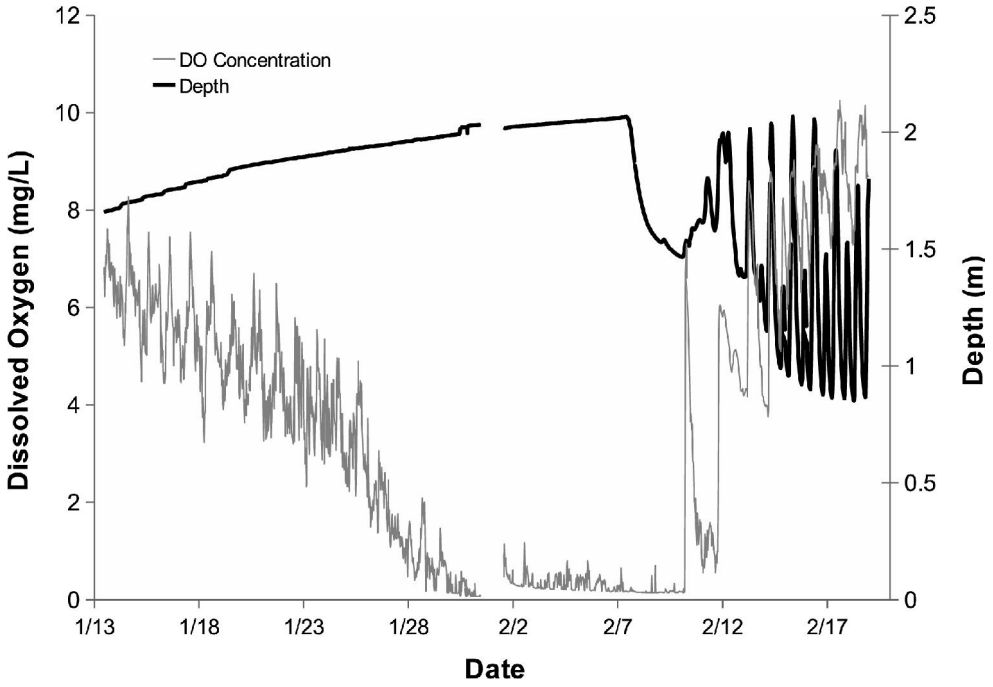
Examine the graph on the previous page for Los Peñasquitos Lagoon to answer the following questions:

1. In San Diego County, there are normally two high tides and two low tides each day. Look at the graph. On what day did the mouth closure at Los Peñasquitos Lagoon make it "appear" that there was only one high tide and one low tide?

2. Hypoxia is when there isn't enough oxygen in the water for aquatic creatures to live. On which day did the water in Los Peñasquitos Lagoon become hypoxic (less than 2 mg/L)? How long did the water remain hypoxic?

3. Why do you think the spike in water level occur at the same time as the spikes in dissolved oxygen?

What happens to the estuary if the mouth doesn't get reopened? The graph below shows dissolved oxygen levels and water depth at Los Peñasquitos Lagoon during a mouth closure event:



Los Peñasquitos Lagoon During a Mouth Closure and After Opening

During the mouth closure, water from the watershed piled up in the lagoon behind the barrier that formed at the estuary mouth. The water level slowly, steadily rose. At the same time, the dissolved oxygen levels decreased and eventually stayed near zero. Clearly, aquatic life within the estuary was suffering at this point. On February 8, workers dredged open the estuary mouth, allowing the hypoxic water within the estuary to flow out and restoring natural flow of ocean water into the estuary via the tides. Dissolved oxygen levels quickly recovered.

Old Woman Creek

Now let's look at a different estuary that experiences mouth closures. Compare these pictures of Old Woman Creek estuary when the estuary mouth is open and when it is closed.

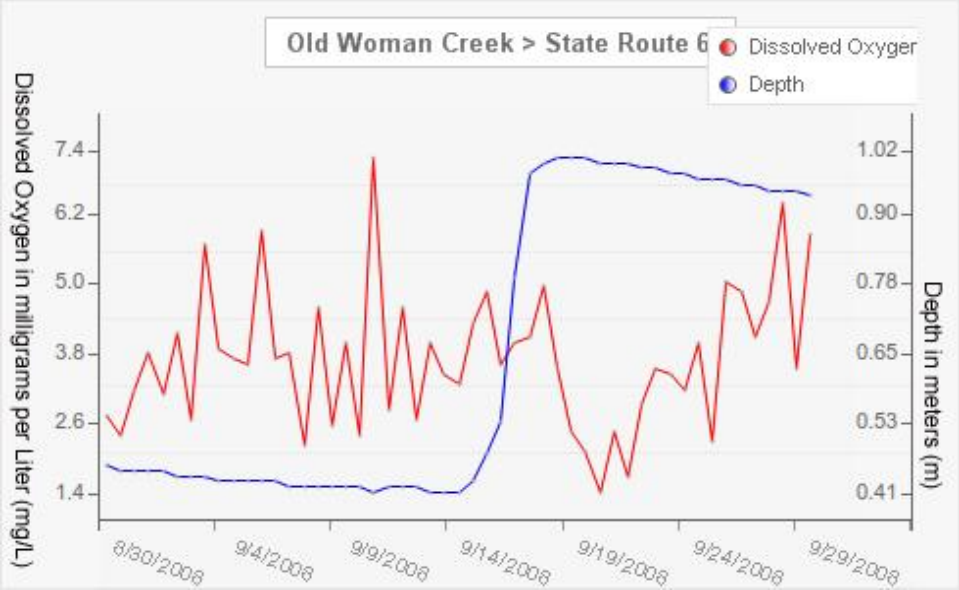
Old Woman Creek estuary after runoff from a heavy rain has cut through the barrier beach, leaving estuary mouth open to Lake Erie.

Old Woman Creek estuary when the mouth has been closed off from Lake Erie by a barrier beach.

Water levels in the Old Woman Creek estuary rise and fall dependent on whether or not the estuary mouth is closed. When the barrier beach closes the mouth of the Old Woman Creek estuary, the barrier beach blocks the flow of water from the lake into the estuary, as well as the flow of water from the estuary out into the lake. The estuary mouth will remain closed until waters from significant rains upstream in the Old Woman Creek watershed create enough water pressure to break through the barrier beach and reopen the mouth. This natural process can occur at any of the Great Lakes estuaries.

At Old Woman Creek, mouth openings and closures occur frequently throughout the year. The barrier beach that closes the estuary mouth at Old Woman Creek is formed from sand moved by currents and wind-driven waves. The wind blowing across Lake Erie sets up the phenomenon called a seiche (pronounced SAYSH). In a seiche, wind-driven water gets pushed down on one end of the lake, piles up on the other end of the lake, and then sloshes back and forth from end to end until water levels return to equilibrium.

When the Old Woman Creek estuary mouth is closed, phytoplankton tend to build up within the estuary. The phytoplankton rapidly produce large amounts of oxygen in the water. In a typical freshwater estuary mouth closure, the dissolved oxygen levels within the estuary drop at first due to the absence of water entering the estuary form the lake. However, because of the phytoplankton, the dissolved oxygen levels usually increase over time.



Old Woman Creek, State Route 6

Examine the graph for Old Woman Creek above and answer the following questions:

4. When did the mouth close at Old Woman Creek estuary? How do you know?

5. Hypoxia is when there isn't enough dissolved oxygen in the water for aquatic creatures to live. What day did the water get hypoxic (DO less than 2 mg/L)?

6. After the mouth closed, there was an abrupt drop in dissolved oxygen. Then the levels of dissolved oxygen began to rise again. What biological process may explain this recovery in DO levels?

7. Before the mouth closed, dissolved oxygen levels experienced a large number of highs and lows. After the mouth closed, oxygen levels show fewer numbers of these same fluctuations. Why?

8. Think about both estuaries you've looked at in this exercise. How do tides, wind, geology, and site characteristics directly impact the nation's estuaries?